The morbidity and mortality conference in pediatric intensive care as a means for improving patient safety

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Abstract: OBJECTIVES: To present our experience in an interdisciplinary and interprofessional morbidity and mortality conference, with special emphasis on its usefulness in improving patient safety. DESIGN: Retrospective analysis. SETTING: Tertiary interdisciplinary neonatal PICU. PATIENTS: Morbidity and mortality conference minutes on 48 patients (newborns to 17 yr), January 2009 to June 2014. INTERVENTIONS: None. MEASUREMENTS AND MAIN RESULTS: The authors' PICU implemented a morbidity and mortality conference guideline in 2009 using a system-based approach to identify medical errors, their contributing factors, and possible solutions. In the subsequent 5.5 years, there were 44 mortality conferences (of 181 deaths [27%] over the same period) and four morbidity conferences. The median death/morbidity event-morbidity and mortality conference interval was 90 days (range, 7 d to 1.5 yr). The median age of patients was 4 months (range, newborn to 17 years). In six cases, the primary reason for PICU admission was a treatment complication. Unsafe processes/medical errors were identified and discussed in 37 morbidity and mortality conferences (77%). In seven cases, new autopsy findings prompted the discussion of a possible error. The 48 morbidity and mortality conferences identified 50 errors, including 30 in which an interface problem was a contributing factor. Fifty-four improvements were identified in 34 morbidity and mortality conferences. Four morbidity and mortality conferences discussed specific ethical issues. CONCLUSIONS: From our experience, we have found that the interdisciplinary and interprofessional morbidity and mortality conference has the potential to reveal unsafe processes/medical errors, in particular, diagnostic and communication errors and interface problems. When formatted as a nonhierarchical tool inviting contributions from all staff levels, the morbidity and mortality conference plays a key role in the system approach to medical errors.

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Objectives: To present our experience in an interdisciplinary and interprofessional morbidity and mortality conference, with special emphasis on its usefulness in improving patient safety.

Design: Retrospective analysis.

Setting: Tertiary interdisciplinary neonatal PICU.

Patients: Morbidity and mortality conference minutes on 48 patients (newborns to 17 yr), January 2009 to June 2014.

Interventions: None.

Measurements and Main Results: The authors' PICU implemented a morbidity and mortality conference guideline in 2009 using a system-based approach to identify medical errors, their contributing factors, and possible solutions. In the subsequent 5.5 years, there were 44 mortality conferences (of 181 deaths [27%] over the same period) and four morbidity conferences. The median death/morbidity event-morbidity and mortality conference interval was 90 days (range, 7 d to 1.5 yr). The median age of patients was 4 months (range, newborn to 17 years). In six cases, the primary reason for PICU admission was a treatment complication. Unsafe processes/medical errors were identified and discussed in 37 morbidity and mortality conferences (77%). In seven cases, new autopsy findings prompted the discussion of a possible error. The 48 morbidity and mortality conferences identified 50 errors, including 30 in which an interface problem was a contributing factor. Fifty-four improvements were identified in 34 morbidity and mortality conferences. Four morbidity and mortality conferences discussed specific ethical issues.

Conclusions: From our experience, we have found that the interdisciplinary and interprofessional morbidity and mortality conference has the potential to reveal unsafe processes/medical errors, in particular, diagnostic and communication errors and interface problems. When formatted as a nonhierarchical tool inviting contributions from all staff levels, the morbidity and mortality conference plays a key role in the system approach to medical errors. (*Pediatr Crit Care Med* 2016; 17:67–72)

Key Words: adverse events; error and risk analysis; medical error; morbidity and mortality conference; patient safety; pediatric intensive care unit

The morbidity and mortality conference (MMC) served traditionally as an educational aid for medical trainees, but more recently, new emphasis has been placed on patient safety and quality improvement (1–8), including critical incident monitoring (9), error and risk analysis (10), postincident team debriefings, and the monitoring of quality indicators and adverse events (11). By identifying adverse events and their cause(s), the MMC prompts intervention and may prevent patient harm (8, 12, 13).

In 2009, we implemented an MMC guideline in our PICU to serve three purposes: 1) teaching, 2) patient safety, and 3) relief of emotional stress in the medical and nursing staff.

To date, there have been at least three studies on the MMC in the PICU, all by Cifra et al (8), (13), (14): a national survey in the United States (8), and two analyses of 96 patients discussed at the Baltimore PICU MMC: the MMC as an adverse event surveillance tool (13) and as a structure for identifying diagnostic error (14). We present our own experience with the introduction of a structured approach, including special emphasis on the usefulness of the MMC in improving patient safety.

METHODS

We conducted a retrospective analysis of the minutes of the MMCs held over 5.5 years, from January 2009 to June 2014, in our 23-bed tertiary interdisciplinary neonatal PICU receiving around 1,400 admissions per year. The unit provides care after neonatal and pediatric surgery, cardiac surgery, and interventional procedures, treats children with trauma or medical conditions, and receives critically ill outborn neonates. It also runs an extracorporeal membrane oxygenation (ECMO) program.

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About 25% of the patients are neonates, mainly with cardiac and/or surgical conditions.

After occasional and unstructured MMCs in earlier years, a structured approach to carry out MMCs was implemented in 2009 under the aegis of a dedicated nurse and a physician. Any care team member (nurse or physician) can propose a case for MMC review. Qualifying cases are deaths and major incidents, regardless of possible medical errors or not. The MMC nurse and physician organize the venue and date and invite a moderator, a case presenter, and the relevant clinical team(s) from inside and outside the hospital (e.g., general practitioner or ambulance personnel). Moderators are not closely involved in the case and must have experience in error and risk analysis; pre-MMC briefings with the presenter are encouraged. The MMC takes place in a closed room, and the moderator approaches people who are unknown to him or her. The single-case, 60-minute format consists of a short case presentation, followed by an overview of autopsy results if available, concluding with a moderator-guided discussion. The discussion includes special attention on a system-based approach, identifying medical errors, their contributing factors, and possible solutions. The moderator is charged with maintaining respectful discussion between MMC participants. Data obtained at MMCs are not used to evaluate staff performance. The moderators also monitor if there are unresolved staff emotional stress related to the MMC discussion. Corrective interventions are identified, and persons are appointed to ensure their implementation. The moderator produces the MMC minutes, comprising date, patient, participants, questions, conclusions, corrective interventions, and responsible persons to monitor their implementation. The protocol is distributed to PICU staff, the heads of other involved disciplines, and the hospital's medical, nursing, and quality directors. The head of the PICU carries overall responsibility for following up the proposed improvements.

We analyzed the protocols of all MMCs held since the implementation of the structured approach with respect to the following parameters: morbidity/mortality, moderator profile, participants, patient characteristics (age, sex, term or premature birth, diagnosis, treatment complication as a main reason for admission, surgery, cardiac catheterization, and ECMO), autopsy data as a pointer to relevant new diagnoses classified by Goldman criteria (15, 16), and death/morbidity event-MMC interval. Wherever the possibility of error was raised, we analyzed whether it met with participant consensus. Error categories included ventilator, invasive (e.g., vascular) device, medical or surgical procedure, infection, drugs, miscommunication (with patient/parents or between staff), and diagnosis (9, 16, 17). We then attributed to each error the most appropriate root cause, whether individual or system-based, such as organization, interface issues, milieu, and equipment dysfunction (9). Interface problems, including handovers, interdisciplinary discussions, and communication with families, were specifically examined. Tasks were assigned to MMC participants to implement solutions across the healthcare system based on the root causes identified during the MMC.

This study was reported to the Zurich canton ethics committee that ruled that ethical approval was not needed.

RESULTS

Forty-eight MMCs were held over the 5.5 years (9 per yr): morbidity, $n = 4$; mortality, $n = 44$ (27% of the 181 deaths over the same period). The median death/morbidity event-MMC interval was 90 days (range, 7 d to 1.5 yr). The median age of patients was 4 months (range, newborn to 17 yr); 21 patients were female. The main diagnoses (cardiac: 18; others: 26) and conference domains (**Table 1**) reflect the distribution of our PICU cases. In six cases, the primary reason for PICU admission was a treatment complication: cerebral hemorrhage during cardiac catheterization, pacemaker dysfunction in the ward, severe pulmonary hypertension after cardiac catheterization, influenza A–triggered acute respiratory distress syndrome in a nonimmunized patient, and myocardial infarction and heart failure in the ward after heart surgery. Fifteen patients were treated with ECMO.

MMCs were held on all 32 autopsies, identifying one or more previously unknown relevant diagnoses in 21 cases (**Table 2**).

In 37 of the 48 MMCs (77%), one or more unsafe processes/medical errors were identified and discussed. Participant consensus on unsafe processes/medical errors was achieved in 31 MMCs; disagreement persisted in five MMCs, and outcome was unknown in one MMC. **Table 3** shows a summary of the categories of error, their root causes, and sites of interventions for improvement. In seven cases, relevant new autopsy findings prompted the discussion of a possible error. In total, 50 errors were identified, including 30 in which an interface problem was

TABLE 1. Principal Diagnoses of 48 Morbidity and Mortality Conference Cases, Domain of Conference

Diagnostic Group	Mortality	Morbidity
Congenital heart disease	17	1
Respiratory disease/acute respiratory distress syndrome	6	1
Perinatal asphyxia	6	
Congenital malformation (other than heart)	5	
Septic shock	3	
Cerebral disease (infarction, spontaneous bleeding, tumor)	3	
Heart disease acquired	1	1
Solid neoplasm		1
Inborn error of metabolism	1	
Trauma	1	
Hemorrhage (other than brain, not traumatic)	1	

TABLE 2. Relevant New Diagnoses Revealed by Autopsy: Goldman Classification (32 Autopsies)

Diagnostic Group	Class 1[a]	Class 2[a]
Placenta	Fetal thrombotic vasculopathy	Chorioamnionitis
		Retardation of villous maturation (2 patients)
Infection		Septic embolism
		Invasive pulmonary aspergillosis
		Necrotizing enterocolitis
		Generalized astrovirus infection
		Cytomegalovirus infection
Genetic/metabolic		Diabetic fetopathia
		Bilateral pulmonary hypoplasia
		Pulmonary lymphangiectasia
		Williams-Beuren syndrome
		Alveolar proteinosis
		Disordered esophageal lamina muscularis
Vascular events	Pulmonary embolism	Retroperitoneal hematoma
	Hemophagocytic lymphohistiocytosis	Morphologic signs for severe pulmonary hypertension
		Rupture of both umbilical arteries
		Sudden cardiac death
		Myocardial ischemia
Central nervous system		Medulloblastoma
		Cerebral malformation

[a]Class 1: missed major diagnosis with potential adverse impact on survival and that would have changed management. Class 2: missed major diagnosis with no potential impact on survival and that would not have changed therapy.

TABLE 3. Categories, Root Causes (Individual Error and System-based Error) as Contributory Factors, and Interventions for Improvement of Discussed Errors ($n = 50$)

Category	Total Number	Individual Error	System-Based Error	Intervention in PICU[a]	Intervention in Hospital[a]	Intervention Outside the Hospital[a]
Diagnostic errors	12	4	8	2	10	2
Wrong communication	12		12	8	4	
Drugs	8	5	3	3	1	4
Ventilator related	7	3	4	1	1	4
Procedure related	4	1	3	2	2	
Invasive devices	4	1	3	4		2
Infections	2		2	1	2	
Documentation	1		1		1	

[a]One error may have led to improvements at several locations (e.g., in the PICU and outside the hospital).

a contributing factor. Fifty-four improvements were decided in 34 MMCs and entered in the minutes (Table 3). **Table 4** provides examples of unsafe processes, including interface problems and solutions. Four MMCs discussed specific ethical issues. An important step at the end of mortality conferences was the appointment of persons to discuss the MMC results

TABLE 4. Examples of Identified Unsafe Processes, Including Interface Problems and Proposed Solutions

Identified Unsafe Process	Interface Problem	Solution
Inborn error of metabolism; late diagnosis	Difficult communication with family (foreign language)	Guideline "nontraumatic coma"
Nosocomial central nervous system infection	Neurological consult not requested	Hygiene measures
Hypoxemia in Fontan patient: delayed diagnostic cardiac catheterization		Early diagnostic cardiac catheterization in Fontan patients with hypoxemia
Pericardial tamponade after removal of surgical implanted central venous catheter in premature infant		Performance of retrospective study on surgical implanted central venous catheters
Dislocation of newly introduced tracheostomy tube in newborn	Communication between PICU consultant and ear-nose-throat consultant	Presence of PICU consultant whenever there are tracheostomy manipulations in the first week after implantation
Cardiac failure after diagnostic cardiac catheterization because of severe pulmonary hypertension	Insufficient briefing before cardiac catheterization and insufficient handover to PICU after cardiac catheterization	New guideline "cardiac catheterization in pulmonary hypertension"
Brainstem compression because of tonsillar herniation during transport from referral hospital to PICU	Insufficient communication between PICU and referral hospital	Early intubation and ventilation with signs of increased intracranial pressure
Septic shock: delayed transfer to PICU because of bed unavailability		Teaching: recognizing early signs of shock
Installation of ECMO in hopeless situation	Insufficient interdisciplinary discussion of ECMO indication	ECMO guidelines
Insufficient ventilation in term newborn with asphyxia because of too small endotracheal tube (2.5 mm)		Provision of all newborn endotracheal tube sizes (in other hospitals)

ECMO = extracorporeal membrane oxygenation.

(autopsy findings and disclosure of identified errors) with the deceased child's family.

In addition to PICU medical staff, medical representatives from almost all disciplines participated depending on the specific cases under discussion (cardiologists, cardiac surgeons, anesthetists, infectiologists, pediatric surgeons, hematologists, and general pediatricians). Nursing staff participated in 31 MMCs, the hospital's quality manager in 11 MMCs, and external staff (pediatricians from other hospitals or in private practice, air rescue personnel, obstetricians, general practitioners, microbiologists, and forensic pathologists) in 20 MMCs.

DISCUSSION

After introducing a structured approach, our PICU organized 48 interdisciplinary and interprofessional MMCs over 5.5 years focused on children with congenital heart disease and fatalities, 73% of whom underwent autopsy. Unsafe processes/medical errors, primarily in diagnosis and communication, were discussed and identified in 77% of MMCs. System-based root causes were far more frequent than individual errors. Interface problems were major contributing factors. Targeted system improvements were entered in the minutes of 34 MMCs.

In a closed-format PICU, such as our own, the pediatric intensivist admits and takes primary responsibility for the patient (18), acting as the general practitioner of acute care (19). Patient safety and the integration of other specialists seamlessly into the care of critically ill children are key concerns for pediatric intensivist-generalists, making the organization of MMCs a natural and important component of their duties. Besides providing safety tools of prime interest for the PICU team, such as critical incident monitoring, the MMC in our format gave the opportunity for interdisciplinary and interprofessional discussion.

In a recent systematic review, Custer et al (16) found major diagnostic errors (Goldman classes 1 and 2) in 19.6% of autopsies in the PICU and neonatal ICU setting. Our study identified missed major diagnoses in 21 of 32 autopsies (66%). However, only seven of these autopsy-revealed diagnostic errors prompted the discussion of possible unsafe processes. The other unsafe processes/errors, including diagnostic errors,

were unrelated to autopsy findings. This is consistent with the recent study by Cifra et al (14): PICU MMCs held on 96 patients identified 20 diagnostic errors, 35% of which were discovered at autopsy and 55% were reported primarily through the MMC. Our high rate of diagnostic errors, miscommunication, and interface problems supports the 2014 study by Cifra et al (13) that found that the MMC is superior to chart review in identifying problems, such as miscommunication, workflow issues, and certain diagnostic errors. We speculate that our interdisciplinary and interprofessional setting enhances the discussion of miscommunication, diagnostic errors, and interface problems.

An adult medicine survey found that case presentations included adverse events in only 37% of internal medicine MMCs and 72% of surgery MMCs (20). Yet, MMCs have been shown to foster cultural change, enabling medical errors and adverse events to be openly discussed with less stigma or individual blame (4). They help to promote a safety culture not only in the PICU but also in other hospital departments while they educate physicians to examine system issues (5). Aiming for such ambitious goals requires a structured approach grounded in an MMC guideline. It also relies heavily on moderators keeping the time frame under control, leaving enough room for open discussion. Moderators should be prepared not only to rephrase or moderate comments that are unsupportive or unsympathetic in tone but also to address the "tough" issues (1). We believe that they should have error and risk analysis experience and be able to apply it within the restricted MMC time frame to the following ends: 1) identifying probable adverse events/medical errors; 2) eliciting input from all staff involved in the case; 3) investigating underlying contributing factors; and 4) appointing persons responsible for following up corrective interventions (8, 21).

The dissemination of the MMC guideline in our hospital has helped enforce implementation of suggested improvements. However, we lack a structured feedback loop. Szekendi et al (3) and Bechtold et al (2) recommended starting each MMC with a brief review of the previous MMC to assess implementation of the proposed interventions (closed-loop quality circle).

There are several approaches for selecting MMC cases. In an adult ICU, the approach adopted by Ksouri et al (22) was to include all deaths and four adverse events (unexpected cardiac arrest, unplanned extubation, reintubation within 24–48 hr after planned extubation, and readmission to the ICU within 48 hr after discharge) occurring over a 1-year period. Another tool to enhance the discovery of adverse events may be for focusing attention on deaths with low predicted mortality. These deaths may be preventable deaths, given their low predicted mortality (e.g., a pediatric index of mortality 2 score of $< 10\%$) (23).

We opted for inviting proposals from anyone in the care team, including cases without obvious medical errors but with an emotional burden because of communication problems. We believe that the MMC also serves to relieve emotional stress in the care team, although this is not implicitly discussed in our guideline and we have no hard data to prove it. Furthermore, we suggest that the presentation and analysis of a case history in an interdisciplinary setting may suffice in themselves to alleviate unjustified feelings of self-accusation. Death in the PICU always causes great emotional stress for all staff involved, who may additionally be prone to self-doubt and guilt (24). For this reason, care team debriefings should take place immediately or within hours to days after the event. Most MMCs by their nature will occur weeks after the death; however, we believe that they still help to address and reduce residual emotional stress (25, 26).

A national survey in the United States has questioned the usefulness of MMCs as presently constituted in improving patient safety: MMCs vary widely in structure and processes, with marked disagreement as to whether they conform to key elements of medical incident analysis (8). Systematic improvements in structure and consistency are necessary if MMCs are to deliver their full potential.

Our study has several limitations. Our morbidity conference rate is rather low, despite the MMC being an excellent interdisciplinary setting in which to discuss morbidity; the low rate may be partly due to our lively critical incident monitoring system that embodies a structured approach to near misses and incidents involving patient harm. In addition, all our MMCs have been a single case: a survey of 75 PICUs in the United States found that 90% discussed two or more cases per MMC (8). In our experience, even a time frame of 60 minutes is rather short for detailed discussion of adverse events and contributing factors in a single case. A further limitation is that we have not performed before and after survey of safety culture or teamwork culture; therefore, we can only speculate as to whether the MMC improves safety culture in our setting. We also make no claim to the MMCs we have described being a comprehensive or failsafe error detection tool. In addition, nursing staff attended only two thirds of the MMCs, whereas one case took 1.5 years to be brought to the MMC because of problems in the Institute of Pathology. Such delays are clearly detrimental to the quality of case discussion. A final limitation is the absence of structured follow-up of corrective interventions.

Organizing and moderating MMCs is an important task for pediatric intensivists. From our experience, we have found that the interdisciplinary and interprofessional MMC has the potential to reveal unsafe processes/medical errors, especially diagnostic errors, miscommunication, and interface problems. The MMC plays an important role in the system approach to medical errors and the promotion of a safety culture. It does this best when formatted as a tool available to all staff, across all grades of the care team. Hence is the importance of minimizing hierarchies so that everyone can have their say (3).

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